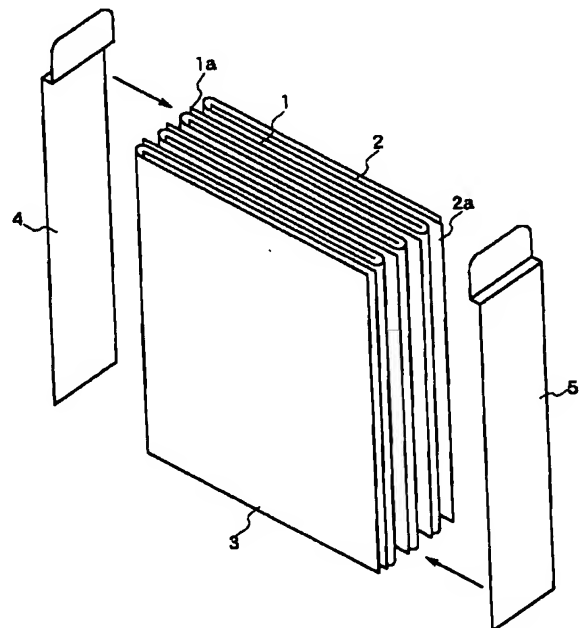| (51)Int.Cl.7		識別記号		F I		テーマコード゛(参考)
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審査請求　未請求　請求項の数10　OL　（全 11 頁）　最終頁に続く

(54)【発明の名称】　角形アルカリ蓄電池、並びにこれを用いた単位電池及び組電池

(57)【要約】
【課題】　発熱量、放熱量及び蓄熱量のバランスを最適化し、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する角形アルカリ蓄電池を提供する。
【解決手段】　それぞれ長方形状の正極板1と負極板2とを同じく長方形状のセパレータ3を介して交互に積層し、電極群を構成する。これらの電極群を、アルカリ電解液と共に角形の電槽内に収納する。内部抵抗を5mΩ以下、電極群の厚みを30mm以下、電解液量を1.3～8.0g／Ahにそれぞれ設定する。

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【特許請求の範囲】

【請求項１】　正極板と負極板とがセパレータによって隔離され、アルカリ電解液とともに電槽内に収納された角形アルカリ蓄電池であって、内部抵抗が５ｍΩ以下であり、前記正極板と前記負極板と前記セパレータとからなる電極群の厚みが３０ｍｍ以下であり、放熱面積が６０ｃｍ²以上であり、電解液量が１．３～８．０ｇ／Ａｈであることを特徴とする角形アルカリ蓄電池。

【請求項２】　電極群の幅方向の両端に正極板と負極板にそれぞれ接合された正極と負極の集電板を備え、各集電板を電槽の短側面に固定して前記電極群を前記電槽内に収納した請求項１に記載の角形アルカリ蓄電池。

【請求項３】　正極板がニッケル酸化物を主体とする正極板であり、負極板が電気化学的に水素の吸蔵放出が可能な水素吸蔵合金を含む負極板である請求項２に記載の角形アルカリ蓄電池。

【請求項４】　セパレータの厚みが０．１～０．３ｍｍである請求項１～３のいずれかに記載の角形アルカリ蓄電池。

【請求項５】　電解液のイオン伝導度が４００～６００ｍＳ／ｃｍである請求項１～３のいずれかに記載の角形アルカリ蓄電池。

【請求項６】　電槽材料の熱伝導度が０．１５Ｗ／ｍ・Ｋ以上であり、電槽の厚みが０．５～１．５ｍｍである請求項１～３のいずれかに記載の角形アルカリ蓄電池。

【請求項７】　３～４０個の単電池を電気的に直列に接続した単位電池であって、前記単電池として請求項１～６のいずれかに記載の角形アルカリ蓄電池を用いたことを特徴とする単位電池。

【請求項８】　幅の狭い短側面と幅の広い長側面とを有する複数の直方体状の電槽をその短側面を隔壁として共用して一体的に成形した一体電槽の各電槽内に電極群を収納して各電槽ごとに単電池を構成すると共に、これらの単電池を電気的に直列に接続した請求項７に記載の単位電池。

【請求項９】　単位電池当たりの熱伝導度が０．３Ｗ／ｍ・Ｋ以上である請求項７又は８に記載の単位電池。

【請求項１０】　単位電池を複数個電気的に直列及び／又は並列に接続し、隣接する前記単位電池間に冷却媒体が通過可能な通路が設けられた組電池であって、前記単位電池として請求項７～９のいずれかに記載の単位電池を用いたことを特徴とする組電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、ニッケル・カドミウム蓄電池やニッケル・水素蓄電池で代表されるアルカリ蓄電池、特に角形アルカリ蓄電池に関する。さらに詳細には、発熱量、放熱量及び蓄熱量のバランスを最適化する電極群、電解液及び電槽の設計に関する。

【０００２】

【従来の技術】ニッケル・カドミウム蓄電池やニッケル・水素蓄電池で代表されるアルカリ蓄電池は、エネルギー密度が高く、信頼性に優れていることから、例えば、ビデオテープレコーダー、ノートパソコン、携帯電話等のポータブル機器の電源として数多く使用されている。実際の使用においては、数個から十数個の単電池を樹脂ケースやチューブの中に収納して使用されるのが一般的である。

【０００３】また、これらのアルカリ蓄電池は、電池容量が０．５Ａｈ～３Ａｈ程度であること、使用される機器が消費する電力も小さいことから、充放電時における単電池当たりの発熱量は小さい。従って、樹脂ケースやチューブの中に収納して使用する場合であっても、発熱と放熱がバランス良く行われ、電池の温度上昇に関する顕著な課題はなかった。

【０００４】

【発明が解決しようとする課題】ところで、最近、家電製品から電気自動車や電気モータで動力をアシストするハイブリッド自動車等の電動車輌に至る移動体用電源として、エネルギー密度が高く、高出力で高信頼性の蓄電池が要望されている。このような用途で電池が使用される場合、数Ａｈ～１００Ａｈ程度の電池容量が必要となる。また、車輌の十分な駆動力を確保するためには、電池電圧を大きくする必要がある。従って、数個から数百個の単電池を直列に接続すること、数十Ａ～数百Ａの負荷電流の入出力を可能にすることが必要となる。

【０００５】電池には、充放電に伴って、電極反応による反応熱やジュール熱が発生し、温度上昇が生ずるが、単電池の電池容量や負荷電流値が増大すると、発生する熱量が増加して、電池外部への放熱が遅れ、発生した熱が電池内部に蓄積されてしまう。その結果、従来の小型電池よりも電池温度が上昇する。また、このような単電池を電気的に直列に接続した単位電池や、単位電池を電気的に直列あるいは並列に接続した組電池は、数十セルから数百セルを隣接させて配置されるため、さらに放熱が遅れ、電池温度の上昇が促進される。そして、このように充電時及び放電時の電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなるという問題が生じる。

【０００６】本発明者等は、電池の発熱量、放熱量及び蓄熱量の関係について検討を行った結果、以下の知見を得た。

【０００７】電池の発熱量は、直流電流を印加した場合の電圧降下によって求められる電池の内部抵抗（Ｒ：電極の反応抵抗と集電部抵抗との総和）により支配され、この内部抵抗値と負荷電流値（Ｉ）の二乗との積（ＲＩ²）によって表される。電池の放熱量は、電池内部で発生した熱の外部への移動、すなわち熱伝導性によって支配されるため、極板の厚みや、複数枚の極板とセパレー

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タとにより構成される電極群の厚みが重要な因子となる。また、電池の放熱量は、電池から熱を奪うための手段（電池外部に流通させる空気や水等の冷媒種やその量）に著しく影響される。また、電池の蓄熱量は、最も熱容量の大きい電解液の量に支配される。

【０００８】電池の温度上昇は、これらの発熱量、放熱量及び蓄熱量のバランスで決定される。すなわち、電池に電流が印加されると、その電流の大きさと電池状態（充電量）に従った電池の内部抵抗とによって熱が発生する。そして、発生した熱は、電池の蓄熱量の大きさに応じて電池温度を上昇させる。また、電池内部で発生した熱は、外部へと伝達し、電池外部との温度差に応じた量の熱が放出される。このような電力の入出力が所定の電池状態の近傍で繰り返されると、発熱量、放熱量及び蓄熱量のそれぞれの大きさとそのバランスに応じた割合で電池温度が上昇し、見かけ上電池温度が一定となる。

【０００９】従って、電池の温度上昇を抑制し、高出力で長寿命のアルカリ蓄電池を得るためには、電池の発熱量、放熱量及び蓄熱量のバランスの最適化を図った電極群、電解液及び電槽の設計が必要となる。

【００１０】本発明は、以上の知見に基づいてなされたものであり、発熱量、放熱量及び蓄熱量のバランスを最適化し、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する角形アルカリ蓄電池、並びにこれを用いた単位電池及び組電池を提供することを目的とする。

【００１１】
【課題を解決するための手段】前記目的を達成するため、本発明に係る角形アルカリ蓄電池の構成は、正極板と負極板とがセパレータによって隔離され、アルカリ電解液とともに電槽内に収納された角形アルカリ蓄電池であって、内部抵抗が５ｍΩ以下であり、前記正極板と前記負極板と前記セパレータとからなる電極群の厚みが３０ｍｍ以下であり、放熱面積が６０ｃｍ^{2}以上であり、電解液量が１．３～８．０ｇ／Ａｈであることを特徴とする。この角形アルカリ蓄電池の構成によれば、発熱量、放熱量及び蓄熱量のバランスが最適化され、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する角型アルカリ蓄電池を実現することができる。

【００１２】また、前記本発明の角形アルカリ蓄電池の構成においては、電極群の幅方向の両端に正極板と負極板にそれぞれ接合された正極と負極の集電板を備え、各集電板を電槽の短側面に固定して前記電極群を前記電槽内に収納するのが好ましい。

【００１３】また、前記本発明の角形アルカリ蓄電池の構成においては、正極板がニッケル酸化物を主体とする正極板であり、負極板が電気化学的に水素の吸蔵放出が可能な水素吸蔵合金を含む負極板であるのが好ましい。

【００１４】また、前記本発明の角形アルカリ蓄電池の

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構成においては、セパレータの厚みが０．１～０．３ｍｍであるのが好ましい。

【００１５】また、前記本発明の角形アルカリ蓄電池の構成においては、電解液のイオン伝導度が４００～６００ｍＳ／ｃｍであるのが好ましい。

【００１６】また、前記本発明の角形アルカリ蓄電池の構成においては、電槽材料の熱伝導度が０．１５Ｗ／ｍ・Ｋ以上であり、電槽の厚みが０．５～１．５ｍｍであるのが好ましい。この条件を満たす電槽材料としては、例えば、ポリフェニレンエーテル樹脂とポリオレフィン樹脂を主体とするポリマーアロイ等の樹脂材料を挙げることができる。

【００１７】また、本発明に係る単位電池の構成は、３～４０個の単電池を電気的に直列に接続した単位電池であって、前記単電池として前記本発明の角形アルカリ蓄電池を用いたことを特徴とする。

【００１８】また、前記本発明の単位電池の構成においては、幅の狭い短側面と幅の広い長側面とを有する複数の直方体状の電槽をその短側面を隔壁として共用して一体的に成形した一体電槽の各電槽内に電極群を収納して各電槽ごとに単電池を構成すると共に、これらの単電池を電気的に直列に接続するのが好ましい。

【００１９】また、前記本発明の単位電池の構成においては、単位電池当たりの熱伝導度が０．３Ｗ／ｍ・Ｋ以上であるのが好ましい。

【００２０】この単位電池の構成によれば、温度上昇を抑制して、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する単位電池を実現することができる。

【００２１】また、本発明に係る組電池の構成は、単位電池を複数個電気的に直列及び／又は並列に接続し、隣接する前記単位電池間に冷却媒体が通過可能な通路が設けられた組電池であって、前記単位電池として前記本発明の単位電池を用いたことを特徴とする。この組電池の構成によれば、温度上昇を抑制して、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する組電池を実現することができる。

【００２２】
【発明の実施の形態】以下、本発明の実施の形態を、角形アルカリ蓄電池の代表的な電池である角形ニッケル・水素蓄電池を例に挙げて説明する。

【００２３】本実施の形態で用いたニッケル正極及び水素吸蔵合金負極は、以下のようにして作製した。

【００２４】すなわち、ニッケル正極の活物質である水酸化ニッケル固溶体としては、平均粒径１０μｍ、嵩密度約２．０ｇ／ｃｃのＣｏ及びＺｎを固溶した粒子を使用した。そして、水酸化ニッケル固溶体粒子の１００重量部に水酸化コバルト７．０重量部と適量の純水とを加えて混合分散させ、活物質スラリとした。この活物質スラリを多孔度９５％、厚み１．３ｍｍの発泡ニッケル多

孔体基板に充填し、80℃の乾燥機内で乾燥させた。その後、ロールプレスを用いて厚みが0．4mmとなるように圧延した。そして、これを、下記（表1）に示す長方形状の所定の寸法に切断して、ニッケル正極とした。

【0025】また、合金組成がMmNi$_{3.5}$ Co$_{0.75}$ Al$_{0.3}$ Mn$_{0.4}$ の水素吸蔵合金をボールミルによって粉砕して平均粒径20μm程度とした合金粉末を結着剤と＊

＊共にパンチングメタルに塗着し、乾燥させた。その後、厚みが0．28mmとなるように圧延した。そして、これを、下記（表1）に示す長方形状の所定の寸法に切断して、水素吸蔵合金負極とした。

【0026】
【表1】

電池容量 [Ah]	電極群厚み [mm]	正極サイズ [mm×mm]	正極厚み [mm]	正極枚数 [枚]	負極サイズ [mm×mm]	負極厚み [mm]	負極枚数 [枚]
8	10	48×83	0．4	9	48×83	0．28	10
8	20	48×48	0．4	16	48×48	0．28	17
8	30	48×32	0．4	25	48×32	0．28	26
8	35	48×28	0．4	29	48×28	0．28	30

【0027】図1は本発明の一実施の形態における角形ニッケル・水素蓄電池の電極群の構成を示す斜視図である。

【0028】図1に示すように、上記（表1）に示す正極板1及び負極板2を、同じく長方形状の親水化処理を施したポリプロピレン繊維不織布からなるセパレータ3を介して交互に積層し、電極厚みの異なる電極群を構成した。この電極群の幅方向両端のリード1a、2aに、鉄にニッケルメッキを施した集電板4、5を端面溶接し、正極、負極の電極端子とした。これらの電極群は、水酸化カリウムを主成分とする電解液と共にポリプロピレン樹脂とポリフェニルエーテル樹脂を主体とするポリマーアロイ製の角形電槽に各集電板4、5を電槽の短側面に固定して収納した。これにより、電池容量8Ahの角形ニッケル・水素蓄電池が得られた。

【0029】以上のような構成を備えた角形ニッケル・水素蓄電池（単電池）の内部抵抗、電極群の厚み、放熱面積、電解液量、電解液のイオン伝導度、電槽の厚み、電槽材料の熱伝導度をそれぞれ変化させ、それらと充放電時の電池の温度上昇及びサイクル寿命との関係について調べた。

【0030】内部抵抗は、電極の反応抵抗、電解液のイオン導電性に関わる抵抗、集電部及び電極芯材の抵抗の総和である。そのため、電池容量、極板面積、集電部や電極芯材の材質や厚み、形状に大きく影響される。しかし、本実施の形態において行った実験では、電池容量及び電池内の極板面積はほぼ一定となるように行ったことから、これらの影響は無視されると考えられる。そのため、ニッケルメッキを施した鉄製の集電板4、5の厚み及びニッケルメッキの厚みを変化させることによって、電池の内部抵抗を変化させた。

【0031】また、内部抵抗の測定は、以下に示す方法によって行った。すなわち、後述する利用率の測定に用いた測定方法により、作製した電池の実容量［Ah］を

求めた。そして、放電状態の電池に実容量に対して50％の充電を施した後、環境温度を25℃として、3時間放置した。その後、下記（表2）に示す条件で電流を印加し、10秒後の電池電圧を測定した。印加した電流値を横軸に、測定した電池電圧を縦軸にプロットした図を作成した。この図から求められる傾きは、オームの法則（V＝R×I）より、電池の内部抵抗を示していると考えられる。従って、電池の内部抵抗は、上記の方法により最小二乗法を用いて算出した。

【0032】
【表2】

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状態	電流値 [A]	時間 [秒]
放電	10	10
休止	—	60
充電	10	10
休止	—	60
放電	25	10
休止	—	60
充電	25	10
休止	—	60
放電	40	10
休止	—	60
充電	40	10
休止	—	60
放電	60	10
休止	—	60
充電	60	10
休止	—	60
放電	80	10
休止	—	60
充電	80	10
休止	—	60
放電	100	10
休止	—	60

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＊【００３３】また、電極群の厚みとは、正極板１と負極板２とセパレータ３とからなる集合体の厚みを意味している（単位：mm）。放熱面積とは、電池外側面で冷却媒体と直接接する面積のことである（単位：cm²）。電解液量は、電池の１Ah容量当たりの電解液の重量である（単位：g／Ah）。電解液のイオン伝導度は、電解液比重に支配される。

【００３４】サイクル寿命は、初期容量の８０％以下となったサイクル数のことである。

（１）内部抵抗と温度上昇、サイクル寿命との関係
下記（表３）に、電極群の厚みを２０mm、放熱面積を１００cm²、電解液量を３g／Ah、セパレータの厚みを０．２mm、電解液のイオン伝導度を５００mS／cmとし、内部抵抗を３～６mΩと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。下記（表３）中の『利用率』は、以下のようにして算出される。すなわち、電池を充電レート０．１CmAで１５時間充電し、放電レート０．２CmAで電池電圧が１．０Vになるまで放電させるサイクルを５サイクル繰り返し、５サイクル目の容量を測定する。このようにして測定した電池容量を理論容量（正極中に充填した水酸化ニッケルの重量に、水酸化ニッケルが１電子反応するとしたときの電気容量２８９mAh／gを乗じて得た値）で除することにより、利用率が算出される。

【００３５】

＊　【表３】

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
3	20	100	3	0.2	500	95	5	1000
4						95	5	1000
5						92	7	900
6						88	14	300

【００３６】上記（表３）に示すように、内部抵抗が３mΩ、４mΩ、５mΩのとき、充放電時の電池の温度上昇はそれぞれ５℃、５℃、７℃、サイクル寿命はそれぞれ１０００、１０００、９００であった。一方、内部抵抗が６mΩのとき、充放電時の電池の温度上昇は１４℃と高くなり、電池のサイクル寿命は３００と短くなっている。内部抵抗が大きくなると、充放電時の電池の発熱量、ひいては電池の温度上昇が大きくなると考えられる。そして、電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。

【００３７】従って、電池の内部抵抗は、５mΩ以下であるのが望ましい。

（２）電極群の厚みと温度上昇、サイクル寿命との関係
下記（表４）に、電池の内部抵抗を４mΩ、放熱面積を１００cm²、電解液量を３g／Ah、セパレータの厚みを０．２mm、電解液のイオン伝導度を５００mS／cmとし、電極群の厚みを１０～３５mmと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。尚、電極群の厚みが異なる電池について放熱面積を一定の値（１００cm²）に調整するために、各電池の電槽外表面に断熱シートを貼った。

【００３８】

【表４】

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
	10					94	7	900
4	20	100	3	0.2	500	95	5	1000
	30					93	7	900
	35					88	12	400

【００３９】上記（表４）に示すように、電極群の厚みが１０ｍｍ、２０ｍｍ、３０ｍｍのとき、充放電時の電池の温度上昇はそれぞれ７℃、５℃、７℃、サイクル寿命はそれぞれ９００、１０００、９００であった。一方、電極群の厚みが３５ｍｍのとき、充放電時の電池の温度上昇は１２℃と高くなり、電池のサイクル寿命は４００と短くなっている。電極枚数が多く、電極群の厚みが大きい場合には、熱拡散速度が小さくなり、電池内部での熱伝導度が小さくなるために、電池の温度上昇が大きくなると考えられる。そして、電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。

【００４０】従って、電極群の厚みは、３０ｍｍ以下であるのが望ましい。

（３）放熱面積と温度上昇、サイクル寿命との関係

下記（表５）に、電池の内部抵抗を４ｍΩ、電極群の厚みを２０ｍｍ、セパレータの厚みを０．２ｍｍ、電解液のイオン伝導度を５００ｍＳ／ｃｍとし、放熱面積を５０～１２０ｃｍ²と変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。尚、放熱面積は、電槽外表面に断熱シートを貼ることにより、所定の面積に調整した。

【００４１】

【表５】

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
		50				87	13	300
		60				93	7	900
4	20	80	3	0.2	500	95	5	1000
		100				95	5	1000
		120				95	4	1000

【００４２】上記（表３）に示すように、放熱面積が６０ｃｍ²、８０ｃｍ²、１００ｃｍ²、１２０ｃｍ²のとき、充放電時の電池の温度上昇はそれぞれ７℃、５℃、５℃、４℃、サイクル寿命はそれぞれ９００、１０００、１０００、１０００であった。一方、放熱面積が５０ｃｍ²のとき、充放電時の電池の温度上昇は１３℃と高くなり、電池のサイクル寿命は３００と短くなっている。放熱面積が小さい場合には、放熱量が小さくなるために、電池の温度上昇が大きくなると考えられる。そして、電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。

【００４３】従って、放熱面積は、６０ｃｍ²以上であるのが望ましい。

（４）電解液量と温度上昇、サイクル寿命との関係

下記（表６）に、電池の内部抵抗を４ｍΩ、電極群の厚みを２０ｍｍ、放熱面積を１００ｃｍ²、セパレータの厚みを０．２ｍｍ、電解液のイオン伝導度を５００ｍＳ／ｃｍとし、電解液量を１．２～８．１ｇ／Ａｈと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。

【００４４】

【表６】

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
			1.2			82	12	400
			1.3			93	7	900
4	20	100	3	0.2	500	95	6	1000
			6			95	5	1000
			8			95	4	900
			8.1			95	4	500

【００４５】上記（表６）に示すように、電解液量が　　　　　１．３ｇ／Ａｈ、３ｇ／Ａｈ、６ｇ／Ａｈ、８ｇ／Ａｈ

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のとき、充放電時の電池の温度上昇はそれぞれ７℃、５℃、５℃、４℃、サイクル寿命はそれぞれ９００、１０００、１０００、９００であった。一方、電解液量が１．２ｇ／Ａｈのとき、充放電時の電池の温度上昇は１２℃と高くなり、電池のサイクル寿命は４００と短くなっている。また、電解液量が８．１ｇ／Ａｈのとき、充放電時の電池の温度上昇は４℃であるが、電池のサイクル寿命は５００と短くなっている。電解液量が少ない場合には、蓄熱量が小さくなるために、充放電時の電池の発熱量、ひいては電池の温度上昇が大きくなると考えられる。そして、電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。また、電解液量が多い場合には、蓄熱量が大きくなるために、充放電時の電池の発熱量、ひいては電池の温度上昇は小さくなるが、その一方で、充電効率が低下して電池の内圧が上昇するために、電池のサイクル寿命は短くなると考えられる。

【００４６】従って、電解液量は、１．３〜８．０ｇ／*

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* Ａｈであるのが望ましい。

【００４７】以上（１）〜（４）の結果をまとめると、内部抵抗が５ｍΩ以下、電極群の厚みが３０ｍｍ以下、放熱面積が６０ｃｍ²以上、電解液量が１．３〜８．０ｇ／Ａｈである場合に、発熱量、放熱量及び蓄熱量のバランスが最適化され、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する角形ニッケル・水素蓄電池が実現される。

（５）セパレータの厚みと温度上昇、サイクル寿命との関係

下記（表７）に、電池の内部抵抗を４ｍΩ、電極群の厚みを２０ｍｍ、放熱面積を１００ｃｍ²、電解液量を３ｇ／Ａｈ、電解液のイオン伝導度を５００ｍＳ／ｃｍとし、セパレータの厚みを０．０８〜０．３２ｍｍと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。

【００４８】

【表７】

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
4	20	100	3	0.08	500	95	7	400
				0.1		95	7	900
				0.15		95	4	1000
				0.2		96	4	1000
				0.25		95	4	1000
				0.3		93	7	900
				0.32		85	12	500

【００４９】上記（表７）に示すように、セパレータの厚みが０．１ｍｍ、０．１５ｍｍ、０．２ｍｍ、０．２５ｍｍ、０．３ｍｍのとき、充放電時の電池の温度上昇はそれぞれ７℃、４℃、４℃、４℃、７℃、サイクル寿命はそれぞれ９００、１０００、１０００、１０００、９００であった。一方、セパレータの厚みが０．０８ｍｍのとき、充放電時の電池の温度上昇は７℃であるが、電池のサイクル寿命は４００と短くなっている。また、セパレータの厚みが０．３２ｍｍのとき、充放電時の電池の温度上昇は１２℃と高くなり、電池のサイクル寿命は５００と短くなっている。セパレータの厚みが小さい場合には、セパレータの吸収する電解液量が少ないことから、結果として電極内の電解液量が多くなり、蓄熱量が大きくなるため、充放電時の電池の発熱量、ひいては電池の温度上昇は小さくなるが、その一方で、充電効率が低下して電池の内圧が上昇するために、電池のサイクル寿命は短くなると考えられる。また、セパレータの厚みが大きい場合には、セパレータの吸収する電解液量が多いことから、結果として電極内の電解液量が少なくな

り、電極の反応抵抗が大きくなるために、充放電時の電池の発熱量、ひいては電池の温度上昇が大きくなると考えられる。そして、電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。

【００５０】従って、セパレータの厚みは、０．１〜０．３ｍｍであるのが望ましい。

（６）電解液のイオン伝導度と温度上昇、サイクル寿命との関係

下記（表８）に、電池の内部抵抗を４ｍΩ、電極群の厚みを２０ｍｍ、放熱面積を１００ｃｍ²、電解液量を３ｇ／Ａｈ、セパレータの厚みを０．２ｍｍとし、電解液のイオン伝導度を３７０〜６５０ｍＳ／ｃｍと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。尚、電解液のイオン伝導度は、電解液の比重を変えることにより、所定の値に調整した。

【００５１】

【表８】

13　　　　　　　　　　　　　　　　　14

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ゚厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
					370	75	12	400
					400	96	7	900
4	20	100	3	0.2	500	98	5	1000
					600	96	7	900
					650	88	13	400

【００５２】上記（表8）に示すように、電解液のイオン伝導度が４００ｍＳ／ｃｍ、５００ｍＳ／ｃｍ、６００ｍＳ／ｃｍのとき、充放電時の電池の温度上昇はそれぞれ７℃、５℃、７℃、サイクル寿命はそれぞれ９００、１０００、９００であった。一方、電解液のイオン伝導度が３７０ｍＳ／ｃｍのとき、充放電時の電池の温度上昇は１２℃と高くなり、電池のサイクル寿命は４００と短くなっている。また、電解液のイオン伝導度が６５０ｍＳ／ｃｍのとき、充放電時の電池の温度上昇は１３℃と高くなり、電池のサイクル寿命は４００と短くなっている。電解液のイオン伝導度が小さい場合には、電解液比重が小さく、液量（ｃｃ）過多となって、電極の反応抵抗が大きくなるために、充放電時の電池の発熱量、ひいては電池の温度上昇が大きくなると考えられる。また、電解液のイオン伝導度が大きい場合には、電解液比重が大きく、液量（ｃｃ）が少なくなって、放熱性が同じであっても蓄熱量は最も熱容量の大きい電解液によって支配されるために、蓄熱量も少なくなり、電池の温度上昇が大きくなると考えられる。そして、電池の＊

＊温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。

【００５３】従って、電解液のイオン伝導度は、４００～６００ｍＳ／ｃｍであるのが望ましい。

（7）電槽材料の熱伝導度と温度上昇、サイクル寿命との関係

下記（表9）に、電池の内部抵抗、電極群の厚み、放熱面積、電解液量、セパレータの厚み、電解液のイオン伝導度を上記（1）～（6）において説明した望ましい値に設定し、電槽の厚みを１．０ｍｍに設定して、電槽材料の熱伝導度を０．１３～０．１８Ｗ／ｍ・Ｋと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。電槽材料の熱伝導度は、使用する樹脂の熱伝導性に支配され、ポリマーアロイ樹脂ではその配合比に支配される。

【００５４】

【表9】

電槽厚み [mm]	熱伝導度 [W/m・K]	利用率 [%]	温度上昇 [℃]	寿命サイクル
	0.13	82	14	400
1.0	0.14	88	11	500
	0.15	93	7	900
	0.18	95	5	1000

【００５５】上記（表9）に示すように、電槽材料の熱伝導度が０．１５Ｗ／ｍ・Ｋ、０．１８Ｗ／ｍ・Ｋのとき、充放電時の電池の温度上昇はそれぞれ７℃、５℃、サイクル寿命はそれぞれ９００、１０００であった。一方、電槽材料の熱伝導度が０．１３Ｗ／ｍ・Ｋ、０．１４Ｗ／ｍ・Ｋのとき、充放電時の電池の温度上昇はそれぞれ１４℃、１１℃と高く、電池のサイクル寿命はそれぞれ４００、５００と短くなっている。電槽材料の熱伝導度が小さい場合には、電池の温度上昇が大きくなり、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進されて、電池のサイク

ル寿命も短くなると考えられる。

（8）電槽の厚みと温度上昇、サイクル寿命との関係

下記（表１０）に、電池の内部抵抗、電極群の厚み、放熱面積、電解液量、セパレータの厚み、電解液のイオン伝導度を上記（1）～（6）において説明した望ましい値に設定し、電槽材料の熱伝導度を０．２Ｗ／ｍ・Ｋに設定して、電槽の厚みを０．４～１．６ｍｍと変化させたときの、充放電時の電池の温度上昇とサイクル寿命の測定結果を示す。

【００５６】

【表１０】

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電槽厚み [mm]	熱伝導度 [W/m・K]	利用率 [%]	温度上昇 [℃]	寿命サイクル
0.4		96	4	400
0.5		96	4	900
0.8		96	5	1000
1.0	0.2	96	5	1000
1.2		95	5	1000
1.5		93	7	900
1.6		86	12	500

【0057】上記（表10）に示すように、電槽の厚みが0.5mm、0.8mm、1.0mm、1.2mm、1.5mmのとき、充放電時の電池の温度上昇はそれぞれ4℃、5℃、5℃、5℃、7℃、サイクル寿命はそれぞれ900、1000、1000、1000、900であった。一方、電槽の厚みが0.4mmのとき、充放電時の電池の温度上昇は4℃であるが、電池のサイクル寿命は400と短くなっている。また、電槽の厚みが1.6mmのとき、充放電時の電池の温度上昇は12℃と高くなり、電池のサイクル寿命は500と短くなっている。電槽の厚みが小さい場合には、放熱性が良好となるために、充放電時の電池の発熱量、ひいては電池の温度上昇は小さくなるが、電池内圧に対して電槽の厚みが不足するために、電槽が変形し、電池のサイクル寿命が短くなると考えられる。また、電槽の厚みが大きい場合には、放熱性が悪くなるために、充放電時の電池の発熱量、ひいては電池の温度上昇が大きくなると考えられる。そして、電池の温度上昇が大きくなると、充電効率の低下、及び電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、電池のサイクル寿命が短くなると考えられる。

【0058】従って、（7）、（8）の結果から、電槽材料の熱伝導度が0.15W/m・K以上であり、電槽の厚みが0.5～1.5mmであるのが望ましい。

【0059】この条件を満たす電槽材料としては、例えば、ポリフェニレンエーテル樹脂とポリオレフィン樹脂を主体とするポリマーアロイ等の樹脂材料を挙げることができる。

【0060】次に、上記のような構成を備えた3～40個の角形ニッケル・水素蓄電池（単電池）を電気的に直列に接続して単位電池を作製した。

【0061】図2に、6個の角形ニッケル・水素蓄電池（単電池）を電気的に直列に接続して単位電池を構成したときの一体電槽の斜視図を示す。図2に示すように、幅の狭い短側面と幅の広い長側面とを有する6個の直方体状の電槽6を、その短側面を隔壁7として共用して一体的に成形した一体電槽8の各電槽6内に電極群（図示せず）が収納されている。すなわち、隣接する単電池同士が隔壁7の上部で電気的に直列に接続されている。両

端の端壁9の上部には、上記単位電池の極端子（図示せず）がそれぞれ設けられている。一体電槽8の上部解放面は、上部カバー（図示せず）によって一体的に閉塞されている。また、一体電槽8の長側面には、隣接する単位電池との間に冷却媒体が通過可能な通路を形成するためのリブ状突起10が設けられている。

（9）単位電池当たりの熱伝導度と温度上昇、サイクル寿命との関係

下記（表11）に、6個の角形ニッケル・水素蓄電池（単電池）を電気的に直列に接続して構成した単位電池において、各単電池の内部抵抗、電極群の厚み、放熱面積、電解液量、セパレータの厚み、電解液のイオン伝導度を上記（1）～（6）において説明した望ましい値に設定し、単位電池当たりの熱伝導度を0.2～0.4W/m・Kと変化させたときの、充放電時の単位電池の温度上昇とサイクル寿命の測定結果を示す。尚、単位電池当たりの熱伝導度は、電槽樹脂材料の配合比、電槽の厚みを変えることにより、所定の値に調整した。

【0062】
【表11】

熱伝導度 [W/m・K]	利用率 [%]	温度上昇 [℃]	寿命サイクル
0.2	82	13	400
0.3	95	6	900
0.4	96	5	1000

【0063】上記（表11）に示すように、単位電池当たりの熱伝導度が0.3W/m・K、0.4W/m・Kのとき、充放電時の単位電池の温度上昇はそれぞれ6℃、5℃、サイクル寿命はそれぞれ900、1000であった。一方、単位電池当たりの熱伝導度が0.2W/m・Kのとき、充放電時の単位電池の温度上昇は13℃と高く、単位電池のサイクル寿命は400と短くなっている。単位電池当たりの熱伝導度が小さい場合には、放熱性が悪くなるために、充放電時の単位電池の発熱量、ひいては単位電池の温度上昇が大きくなると考えられる。そして、単位電池の温度上昇が大きくなると、充電効率の低下、及び単電池内に配置されたセパレータや電極内の結着剤などの分解が促進され、単位電池のサイク

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ル寿命が短くなると考えられる。

【００６４】従って、単位電池当たりの熱伝導度は、０．３Ｗ／ｍ・Ｋ以上であるのが望ましい。

【００６５】このように、上記（１）〜（９）において説明した望ましい値に設定された角形ニッケル・水素蓄電池（単電池）を用いて単位電池を構成し、かつ、単位電池当たりの熱伝導度を０．３Ｗ／ｍ・Ｋ以上に設定することにより、温度上昇を抑制して、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する単位電池を実現することができる。

【００６６】次に、上記のような構成を備えた単位電池を複数個電気的に直列及び／又は並列に接続して組電池を作製した。隣接する単位電池間には、冷却媒体が通過可能な通路が設けられている。この場合にも、（９）において説明した望ましい値に設定された単位電池を用いて組電池を構成することにより、温度上昇を抑制して、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する組電池を実現することができた。

【００６７】

【発明の効果】以上説明したように、本発明によれば、発熱量、放熱量及び蓄熱量のバランスを最適化し、高出＊

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＊力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する角形アルカリ蓄電池を実現することができる。また、本発明の角形アルカリ蓄電池を用いることにより、温度上昇を抑制して、高出力で、充放電の繰り返しや長期間の使用においても優れた電池特性を有する単位電池及び組電池を実現することもできる。
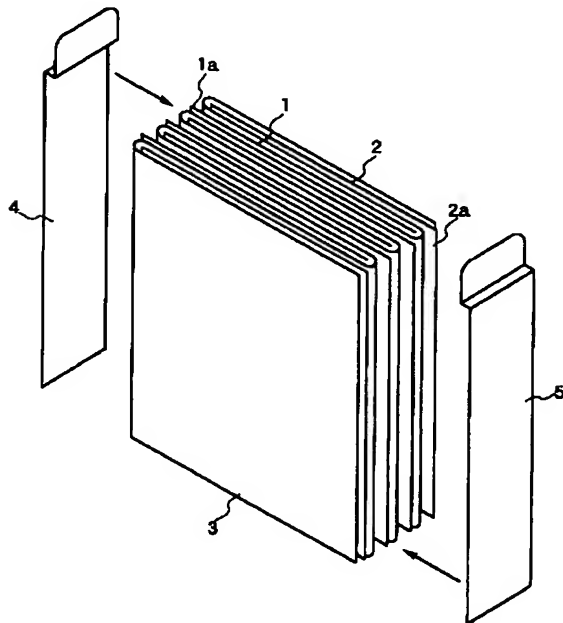
【図面の簡単な説明】

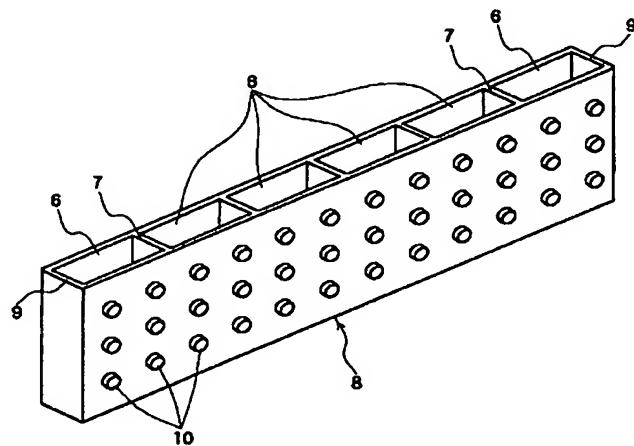【図１】本発明の一実施の形態における電極群構成を示す斜視図

【図２】本発明の一実施の形態における単位電池を構成する一体電槽を示す斜視図

【符号の説明】

1　正極板
2　負極板
3　セパレータ
4　集電板
5　集電板
6　電槽
7　隔壁
8　一体電槽
9　端壁
10　リブ状突起

【図１】

【図２】

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(54) SQUARE ALKALINE STORAGE BATTERY, AND UNIT BATTERY AND ASSEMBLED BATTERY USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a square alkaline storage battery that can optimize the balance between heat generation volume, heat radiation volume and heat storage volume, and has high output and excellent battery characteristics even in the repetition of charge and discharge and in a long-term use.
SOLUTION: Rectangular positive plates 1 and negative plates 2 are laminated alternately through also rectangular separators 3, and electrode groups are constructed. These electrode groups are housed in a square casing together with alkaline electrolyte. Inside resistance is set at 5 mΩ or less, thickness of the electrode groups at 30 mm or less, and the volume of the electrolytic solution is at 1.3 to 8.0 g/Ah, respectively.

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is the square shape alkaline battery with which it was isolated with the separator and the positive-electrode plate and the negative-electrode plate were contained in the battery case with the alkali electrolytic solution, the thickness of the electrode group which internal resistance is less than [5mohm], and becomes from said positive-electrode plate, said negative-electrode plate, and said separator is 30mm or less, and a heat sinking plane product is 2 60cm. Square shape alkaline battery characterized by being above and the amount of electrolytic solutions being 1.3 - 8.0 g/Ah.
[Claim 2] The square shape alkaline battery according to claim 1 which was equipped with the collecting electrode plate of the positive electrode joined to the positive-electrode plate and the negative-electrode plate by the both ends of the cross direction of an electrode group, respectively, and a negative electrode, fixed each collecting electrode plate to the short side face of a battery case, and contained said electrode group in said battery case.
[Claim 3] The square shape alkaline battery according to claim 2 which a positive-electrode plate is a positive-electrode plate which makes a nickel oxide a subject, and is the negative-electrode plate with which a negative-electrode plate contains electrochemically the hydrogen storing metal alloy in which occlusion emission of hydrogen is possible.
[Claim 4] The square shape alkaline battery according to claim 1 to 3 whose thickness of a separator is 0.1-0.3mm.
[Claim 5] The square shape alkaline battery according to claim 1 to 3 whose ionic conductivity of the electrolytic solution is 400 - 600 mS/cm.
[Claim 6] The square shape alkaline battery according to claim 1 to 3 whose thickness of a battery case the thermal conductivity of a battery case ingredient is 0.15 or more W/m-K, and is 0.5-1.5mm.
[Claim 7] The unit cell which is a unit cell which connected 3-40 cells to the serial electrically, and is characterized by using a square shape alkaline battery according to claim 1 to 6 as said cell.
[Claim 8] The unit cell according to claim 7 which connected these cells to the serial electrically while containing the electrode group and really which shared the short side face as a septum, and fabricated in one the battery case of the shape of two or more rectangular parallelepiped which has the short side face where width of face is narrow, and the long side face where width of face is wide constituting the cell for every battery case in each battery case of a battery case.
[Claim 9] The unit cell according to claim 7 or 8 whose thermal conductivity per unit cell is 0.3 or more W/m-K.
[Claim 10] The group cell which is a group cell by which two or more unit cells were electrically connected to a serial and/or juxtaposition, and the path which can pass a cooling medium was prepared between said adjoining unit cells, and is characterized by using a unit cell according to claim 7 to 9 as said unit cell.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the alkaline battery represented with a nickel cadmium battery, or nickel and a hydrogen battery, especially a square shape alkaline battery. Furthermore, it is related with the design of the electrode group which optimizes the balance of calorific value, heat release, and the amount of accumulation in a detail, the electrolytic solution, and a battery case.
[0002]
[Description of the Prior Art] The alkaline battery represented with a nickel cadmium battery, or nickel and a hydrogen battery has a high energy density, and are used from excelling in dependability as a power source of portable devices, such as a video tape recorder, a notebook computer, and a cellular phone, for example. [many] In a actual activity, it is common that about ten cells are used into a resin case or a tube from some, containing.
[0003] Moreover, since the power with which cell capacity's being 0.5Ah(s) - 3Ah extent and the device used consume these alkaline batteries is also small, the calorific value per cell at the time of charge and discharge is small. Therefore, even if it was the case where it was contained and used into a resin case or a tube, generation of heat and heat dissipation were performed with sufficient balance, and there was no remarkable technical problem about the temperature rise of a cell.
[0004]
[Problem(s) to be Solved by the Invention] By the way, as a power source for mobiles which results in electric vehicles, such as a hybrid car which assists power by the electric vehicle or the electric motor from home electronics, an energy density is high and the highly reliable battery is demanded by high power recently. When a cell is used for such an application, the cell capacity which is Number Ah - 100Ah extent is needed. Moreover, in order to secure sufficient driving force of a vehicle, it is necessary to enlarge cell voltage. Therefore, it is necessary to connect hundreds of cells to a serial from some, and to enable I/O of the load current of several 10A - hundreds A.
[0005] Although the heat of reaction and the Joule's heat by electrode reaction occur on a cell and a temperature rise arises in connection with charge and discharge on it, if the cell capacity and the load current value of a cell increase, the heating value to generate increases, the heat dissipation to the cell exterior will be accumulated in delay, and the generated heat will be accumulated in the interior of a cell. Consequently, cell temperature rises rather than the conventional small cell. Moreover, since the unit cell which connected such a cell to the serial electrically, and the group cell which connected the unit cell to a serial or juxtaposition electrically make hundreds cels adjoin and is arranged from dozens cels, lifting of delay and cell temperature is further promoted for heat dissipation. And if the temperature rise of the cell at the time of charge and discharge becomes large in this way, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and the problem that the cycle life of a cell becomes short will arise.
[0006] this invention person etc. acquired the following knowledge, as a result of considering relation between the calorific value of a cell, heat release, and the amount of accumulation.
[0007] The calorific value of a cell is governed by the internal resistance (R: total with reaction resistance of an electrode, and current collection section resistance) of the cell called for by the voltage drop at the time of impressing a direct current, and is expressed by the product (RI2) with square of this internal resistance value and a load current value (I). Since the heat release of a cell is governed by the migration to the exterior of the heat generated inside the cell, i.e., thermal conductivity, the thickness of a plate and the thickness of the electrode group constituted with the plate of two or more sheets and a separator serve as an important

factor. Moreover, the heat release of a cell is remarkably influenced by the means (refrigerant kinds which circulate the cell exterior, such as air and water, and amount of those) for taking heat from a cell. Moreover, the amount of accumulation of a cell is governed by the amount of the electrolytic solution with the largest heat capacity.

[0008] It opts for the temperature rise of a cell in the balance of such calorific value, heat release, and the amount of accumulation. That is, if a current is impressed to a cell, heat will occur with the magnitude of the current, and the internal resistance of the cell according to a cell condition (charge). And the generated heat raises cell temperature according to the magnitude of the amount of accumulation of a cell. Moreover, the heat generated inside the cell is transmitted to the exterior, and the heat of the amount according to a temperature gradient with the cell exterior is emitted. If I/O of such power is repeated near the predetermined cell condition, cell temperature will rise at a rate according to each magnitude and its balance of calorific value, heat release, and the amount of accumulation, and cell temperature will become fixed seemingly.

[0009] Therefore, in order to control the temperature rise of a cell and to obtain a long lasting alkaline battery by high power, the design of the electrode group aiming at optimization of the balance of the calorific value of a cell, heat release, and the amount of accumulation, the electrolytic solution, and a battery case is needed.

[0010] This invention is made based on the above knowledge, optimizes the balance of calorific value, heat release, and the amount of accumulation, is high power and aims at offering the square shape alkaline battery which has the cell property which was excellent also in the repeat of charge and discharge, or the prolonged activity, the unit cell which used this for the list, and a group cell.

[0011]
[Means for Solving the Problem] In order to attain said object, the configuration of the square shape alkaline battery concerning this invention It is the square shape alkaline battery with which it was isolated with the separator and the positive-electrode plate and the negative-electrode plate were contained in the battery case with the alkali electrolytic solution. The thickness of the electrode group which internal resistance is less than [5mohm], and becomes from said positive-electrode plate, said negative-electrode plate, and said separator is 30mm or less, and a heat sinking plane product is 2 60cm. It is above and is characterized by the amount of electrolytic solutions being 1.3 - 8.0 g/Ah. According to the configuration of this square shape alkaline battery, the balance of calorific value, heat release, and the amount of accumulation is optimized, and the square shape alkaline battery which has the cell property which was excellent in high power also in the repeat of charge and discharge or the prolonged activity can be realized.

[0012] Moreover, in the configuration of the square shape alkaline battery of said this invention, it is desirable to have the collecting electrode plate of the positive electrode joined to the positive-electrode plate and the negative-electrode plate by the ends of the cross direction of an electrode group, respectively and a negative electrode, to fix each collecting electrode plate to the short side face of a battery case, and to contain said electrode group in said battery case.

[0013] Moreover, in the configuration of the square shape alkaline battery of said this invention, it is desirable that it is the positive-electrode plate with which a positive-electrode plate makes a nickel oxide a subject, and is the negative-electrode plate with which a negative-electrode plate contains electrochemically the hydrogen storing metal alloy in which occlusion bleedoff of hydrogen is possible.

[0014] Moreover, in the configuration of the square shape alkaline battery of said this invention, it is desirable that the thickness of a separator is 0.1-0.3mm.

[0015] Moreover, in the configuration of the square shape alkaline battery of said this invention, it is desirable that the ionic conductivity of the electrolytic solution is 400 - 600 mS/cm.

[0016] Moreover, in the configuration of the square shape alkaline battery of said this invention, the thermal conductivity of a battery case ingredient is 0.15 or more W/m-K, and it is desirable that the thickness of a battery case is 0.5-1.5mm. As a battery case ingredient which fulfills this condition, resin ingredients, such as a polymer alloy which makes polyphenylene ether resin and polyolefin resin a subject, can be mentioned, for example.

[0017] Moreover, the configuration of the unit cell concerning this invention is the unit cell which connected 3-40 cells to the serial electrically, and is characterized by using the square shape alkaline battery of said this invention as said cell.

[0018] Moreover, in the configuration of the unit cell of said this invention, while containing an electrode group and really which shared the short side face as a septum, and fabricated in one the battery case of the shape of two or more rectangular parallelepiped which has the short side face where width of face is narrow,

and the long side face where width of face is wide constituting a cell for every battery case in each battery case of a battery case, it is desirable to connect these cells to a serial electrically.

[0019] Moreover, in the configuration of the unit cell of said this invention, it is desirable that the thermal conductivity per unit cell is 0.3 or more W/m-K.

[0020] According to the configuration of this unit cell, a temperature rise can be controlled and the unit cell which has the cell property which was excellent in high power also in the repeat of charge and discharge or the prolonged activity can be realized.

[0021] Moreover, the configuration of the group cell concerning this invention is the group cell by which two or more unit cells were electrically connected to a serial and/or juxtaposition, and the path which can pass a cooling medium was prepared between said adjoining unit cells, and is characterized by using the unit cell of said this invention as said unit cell. According to the configuration of this group cell, a temperature rise can be controlled and the group cell which has the cell property which was excellent in high power also in the repeat of charge and discharge or the prolonged activity can be realized.

[0022]
[Embodiment of the Invention] Hereafter, the square shape nickel and the hydrogen battery which is a typical cell of a square shape alkaline battery about the gestalt of operation of this invention are mentioned as an example, and is explained.

[0023] The nickel positive electrode and hydrogen storing metal alloy negative electrode which were used with the gestalt of this operation were produced as follows.

[0024] That is, as the nickel hydroxide solid solution which is the active material of a nickel positive electrode, the mean particle diameter of 10 micrometers and the particle which dissolved Co and Zn of about 2.0g/cc of bulk density were used. And the cobalt hydroxide 7.0 weight section and the pure water of optimum dose are added to the 100 weight sections of a nickel hydroxide solid-solution particle, mixed distribution was carried out, and it considered as the active material slurry. The foaming nickel porous body substrate with a% [of porosity] of 95 and a thickness of 1.3mm was filled up with this active material slurry, and it was made to dry within a 80-degree C dryer. Then, it rolled out so that thickness might be set to 0.4mm using a roll press. And this was cut in the predetermined dimension of the shape of a rectangle shown below (table 1), and was made into the nickel positive electrode.

[0025] Moreover, an alloy presentation is MmNi3.5 Co0.75aluminum0.3 Mn0.4. The punching metal was made to apply and dry with a binder the end of an alloy powder which the ball mill ground the hydrogen storing metal alloy, and was made into about 20 micrometers of mean diameters. Then, it rolled out so that thickness might be set to 0.28mm. And this was cut in the predetermined dimension of the shape of a rectangle shown below (table 1), and was made into the hydrogen storing metal alloy negative electrode.

[0026]
[A table 1]

電池容量 [Ah]	電極群 厚み [mm]	正極サイズ [mm×mm]	正極厚み [mm]	正極枚数 [枚]	負極サイズ [mm×mm]	負極厚み [mm]	負極枚数 [枚]
8	10	48×83	0.4	9	48×83	0.28	10
8	20	48×48	0.4	16	48×48	0.28	17
8	30	48×32	0.4	25	48×32	0.28	26
8	35	48×28	0.4	29	48×28	0.28	30

[0027] Drawing 1 is the perspective view showing the configuration of the electrode group of the square shape nickel and the hydrogen battery in the gestalt of 1 operation of this invention.

[0028] As shown in drawing 1 , the laminating of the positive-electrode plate 1 and the negative-electrode plate 2 which are shown above (table 1) was carried out by turns through the separator 3 which consists of a polypropylene fiber nonwoven fabric which similarly performed rectangle-like processing [hydrophilization], and the electrode group from which electrode thickness differs was constituted. End-face welding of the collecting electrode plates 4 and 5 which performed nickel plating to iron was carried out, and it considered as the electrode terminal of a positive electrode and a negative electrode at the leads 1a and 2a of the crosswise ends of this electrode group. These electrode groups fixed and contained each collecting electrode plates 4 and 5 on the short side face of a battery case with the electrolytic solution which uses a potassium hydroxide as a principal component to the square shape battery case made from a

polymer alloy which makes polypropylene resin and polyphenyl-ether resin a subject. Thereby, the square shape nickel and the hydrogen battery of cell capacity 8Ah were obtained.

[0029] The internal resistance of the square shape nickel and a hydrogen battery equipped with the above configurations (cell), the thickness of an electrode group, a heat sinking plane product, the amount of electrolytic solutions, the ionic conductivity of the electrolytic solution, the thickness of a battery case, and the thermal conductivity of a battery case ingredient were changed, respectively, and were investigated about the relation between the temperature rise of the cell at the time of them and charge and discharge, and a cycle life.

[0030] Internal resistance is total of resistance of reaction resistance of an electrode, the resistance in connection with the ion conductivity of the electrolytic solution, the current collection section, and an electrode core material. Therefore, it is greatly influenced by cell capacity, plate area, the current collection section, the construction material of an electrode core material and thickness, and the configuration. however, in the experiment conducted in the gestalt of this operation, since it carried out so that cell capacity and the plate area in a cell might serve as about 1 law, it is thought that these effects are disregarded. Therefore, the internal resistance of a cell was changed by changing the thickness of the iron collecting electrode plates 4 and 5 which performed nickel plating, and the thickness of nickel plating.

[0031] Moreover, measurement of internal resistance was performed by the approach shown below. That is, the net volume [Ah] of the produced cell was calculated with the measuring method used for measurement of the utilization factor mentioned later. And after performing 50% of charge to the cell of a discharge condition to net volume, it was left for 3 hours, having used environmental temperature as 25 degrees C. Then, the current was impressed on the conditions shown below (table 2), and the cell voltage of 10 seconds after was measured. Drawing which plotted the cell voltage which measured the impressed current value on the axis of abscissa on the axis of ordinate was created. The inclination called for from this drawing is considered that the internal resistance of a cell is shown from Ohm's law (V=RxI). Therefore, the internal resistance of a cell was computed using the least square method by the above-mentioned approach.

[0032]

[A table 2]

状 態	電 流 値 [A]	時 間 [秒]
放 電	1 0	1 0
休 止	—	6 0
充 電	1 0	1 0
休 止	—	6 0
放 電	2 5	1 0
休 止	—	6 0
充 電	2 5	1 0
休 止	—	6 0
放 電	4 0	1 0
休 止	—	6 0
充 電	4 0	1 0
休 止	—	6 0
放 電	6 0	1 0
休 止	—	6 0
充 電	6 0	1 0
休 止	—	6 0
放 電	8 0	1 0
休 止	—	6 0
充 電	8 0	1 0
休 止	—	6 0
放 電	1 0 0	1 0
休 止	—	6 0

[0033] Moreover, the thickness of an electrode group means the thickness of the aggregate which consists of the positive-electrode plate 1, a negative-electrode plate 2, and a separator 3 (unit: mm). A heat sinking plane product is an area which touches a cooling medium directly by the cell lateral surface (unit: cm2). The amount of electrolytic solutions is the weight of the electrolytic solution per 1Ah capacity of a cell (unit: g/Ah). The ionic conductivity of the electrolytic solution is governed by electrolytic-solution specific gravity.

[0034] A cycle life is the number of cycles which became 80% or less of initial capacity.

(1) Thickness of an electrode group is made to 20mm, ionic conductivity of 0.2mm and the electrolytic solution is made [a heat sinking plane product / 2 and the amount of electrolytic solutions] into 500 mS/cm for the thickness of 3 g/Ah and a separator 100cm, and the measurement result of the temperature rise of the cell at the time of charge and discharge when changing internal resistance with 3-6mohm and a cycle life is shown in the related following (table 3) of internal resistance, and a temperature rise and a cycle life. The "utilization factor" in the following (table 3) is computed as follows. That is, a cell is charged by charge rate 0.1CmA for 15 hours, and the capacity of 5 cycle repeat and 5 cycle eye is measured for the cycle made to discharge until cell voltage is set to 1.0V by discharge rate 0.2CmA. Thus, a utilization factor is computed by **(ing) measured cell capacity by geometric capacity (value which multiplied by it and obtained electric capacity 289 mAh/g when presupposing that one electron of nickel hydroxide reacts in the weight of the nickel hydroxide with which it was filled up into the positive electrode).

[0035]

[A table 3]

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
3	20	100	3	0.2	500	95	5	1000
4						95	5	1000
5						92	7	900
6						88	14	300

[0036] As shown above (table 3), when internal resistance was 3mohm, 4mohm, and 5mohm, 5 degrees C, 5 degrees C, 7 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 1000, 1000, and 900, respectively. On the other hand, when internal resistance is 6mohm, the temperature rise of the cell at the time of charge and discharge becomes high with 14 degrees C, and the cycle life of a cell is short with 300. If internal resistance becomes large, it will be thought that the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short.

[0037] Therefore, as for the internal resistance of a cell, it is desirable that it is less than [5mohm].

(2) Internal resistance of a cell is made to 4mohm, ionic conductivity of 0.2mm and the electrolytic solution is made [a heat sinking plane product / 2 and the amount of electrolytic solutions] into 500 mS/cm for the thickness of 3 g/Ah and a separator 100cm, and the measurement result of the temperature rise of the cell at the time of charge and discharge when changing the thickness of an electrode group with 10-35mm and a cycle life is shown in the related following (table 4) of the thickness of an electrode group, and a temperature rise and a cycle life. In addition, in order to adjust a heat sinking plane product to a fixed value (100cm2) about the cell by which the thickness of an electrode group differs, the heat insulation sheet was stuck on the battery case outside surface of each cell.

[0038]

[A table 4]

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
4	10	100	3	0.2	500	94	7	900
	20					95	5	1000
	30					93	7	900
	35					88	12	400

[0039] As shown above (table 4), when the thickness of an electrode group was 10mm, 20mm, and 30mm, 7 degrees C, 5 degrees C, 7 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 900, 1000, and 900, respectively. On the other hand, when the thickness of an electrode group is 35mm, the temperature rise of the cell at the time of charge and discharge becomes high with 12 degrees C, and the cycle life of a cell is short with 400. There is much electrode number of sheets, and since a thermal diffusion rate becomes small and the thermal conductivity inside a cell becomes small when the thickness of an electrode group is large, it is thought that the temperature rise of a cell becomes large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short.

[0040] Therefore, as for the thickness of an electrode group, it is desirable that it is 30mm or less.

(3) the related following (table 5) of a heat sinking plane product, and a temperature rise and a cycle life -- the internal resistance of a cell -- the thickness of 4mohm and an electrode group -- 20mm and the amount of electrolytic solutions -- the thickness of 3 g/Ah and a separator -- the ionic conductivity of 0.2mm and the electrolytic solution -- 500 mS/cm -- carrying out -- a heat sinking plane product -- 50-120cm2 The measurement result of the temperature rise of the cell at the time of charge and discharge at the time of making it change and a cycle life is shown. In addition, the heat sinking plane product was adjusted to a predetermined area by sticking a heat insulation sheet on a battery case outside surface.

[0041]
[A table 5]

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
4	20	50	3	0.2	500	87	13	300
		60				93	7	900
		80				96	5	1000
		100				95	5	1000
		120				95	4	1000

[0042] it is shown above (table 3) -- as -- a heat sinking plane product -- 60cm2, 80cm2, 100cm2, and 120cm2 it is -- the time -- the time of charge and discharge -- 7 degrees C, 5 degrees C, 5 degrees C, 4 degrees C, and the cycle lives of the temperature rise of a cell were 900, 1000, 1000, and 1000, respectively. on the other hand -- a heat sinking plane product -- 50cm2 it is -- the time -- the time of charge and discharge -- as for a temperature rise, a cell becomes high with 13 degrees C, and the cycle life of a cell is short with 300. Since heat release becomes small when a heat sinking plane product is small, it is thought that the temperature rise of a cell becomes large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short.

[0043] Therefore, a heat sinking plane product is 2 60cm. It is desirable that it is above.

(4) Thickness of 4mohm and an electrode group is made to 20mm, ionic conductivity of 0.2mm and the electrolytic solution is made [the internal resistance of a cell / a heat sinking plane product] into 500 mS/cm for the thickness of 2 and a separator 100cm, and the measurement result of the temperature rise of the cell at the time of charge and discharge when changing the amount of electrolytic solutions with 1.2 - 8.1 g/Ah and a cycle life is shown in the related following (table 6) of the amount of electrolytic solutions, and a temperature rise and a cycle life.

[0044]
[A table 6]

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
4	20	100	1.2	0.2	500	82	12	400
			1.3			93	7	900
			3			95	5	1000
			6			95	5	1000
			8			95	4	900
			8.1			95	4	500

[0045] As shown above (table 6), when the amounts of electrolytic solutions were 1.3 g/Ah, 3 g/Ah, 6 g/Ah, and 8 g/Ah, 7 degrees C, 5 degrees C, 5 degrees C, 4 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 900, 1000, 1000, and 900, respectively. On the other hand, when the amount of electrolytic solutions is 1.2 g/Ah, the temperature rise of the cell at the time of charge and discharge becomes high with 12 degrees C, and the cycle life of a cell is short with 400. Moreover, when the amount of electrolytic solutions is 8.1 g/Ah, although the temperature rise of the cell at the time of charge and discharge is 4 degrees C, the cycle life of a cell is short with 500. Since the amount of accumulation becomes small when there are few amounts of electrolytic solutions, it is thought that the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short. Moreover, since the amount of accumulation becomes large when there are many amounts of electrolytic solutions, the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become small, but it is one of these, and since charging efficiency falls and the internal pressure of a cell rises, it is thought that the cycle life of a cell becomes short.

[0046] Therefore, as for the amount of electrolytic solutions, it is desirable that it is 1.3 - 8.0 g/Ah.

[0047] When the result of (1) - (4) is summarized above, for the thickness of less than [5mohm] and an electrode group, 30mm or less and a heat sinking plane product are [internal resistance] 2 60cm. When the amount of electrolytic solutions is 1.3 - 8.0 g/Ah above, the balance of calorific value, heat release, and the amount of accumulation is optimized, and the square shape nickel and the hydrogen battery which has the cell property which was excellent in high power also in the repeat of charge and discharge or the prolonged activity are realized.

(5) Thickness of 4mohm and an electrode group is made to 20mm, ionic conductivity of 3 g/Ah and the electrolytic solution is made [the internal resistance of a cell / a heat sinking plane product] into 500 mS/cm for 2 and the amount of electrolytic solutions 100cm, and the measurement result of the temperature rise of the cell at the time of charge and discharge when changing the thickness of a separator with 0.08-0.32mm and a cycle life is shown in the related following (table 7) of the thickness of a separator, and a temperature rise and a cycle life.

[0048]

[A table 7]

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [℃]	寿命サイクル
4	20	100	3	0.08	500	95	7	400
				0.1		95	7	900
				0.15		96	4	1000
				0.2		96	4	1000
				0.25		95	4	1000
				0.3		93	7	900
				0.32		85	12	500

[0049] As shown above (table 7), when the thickness of a separator was 0.1mm, 0.15mm, 0.2mm, 0.25mm, and 0.3mm, 7 degrees C, 4 degrees C, 4 degrees C, 4 degrees C, 7 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 900, 1000, 1000, 1000, and 900,

respectively. On the other hand, when the thickness of a separator is 0.08mm, although the temperature rise of the cell at the time of charge and discharge is 7 degrees C, the cycle life of a cell is short with 400. Moreover, when the thickness of a separator is 0.32mm, the temperature rise of the cell at the time of charge and discharge becomes high with 12 degrees C, and the cycle life of a cell is short with 500. Since there are few amounts of electrolytic solutions which a separator absorbs, the amount of electrolytic solutions in an electrode increases as a result and the amount of accumulation becomes large when the thickness of a separator is small, the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become small, but it is one of these, and since charging efficiency falls and the internal pressure of a cell rises, it is thought that the cycle life of a cell becomes short. Moreover, since there are many amounts of electrolytic solutions which a separator absorbs, the amount of electrolytic solutions in an electrode decreases as a result and reaction resistance of an electrode becomes large when the thickness of a separator is large, it is thought that the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short.

[0050] Therefore, as for the thickness of a separator, it is desirable that it is 0.1-0.3mm.

(6) Thickness of 4mohm and an electrode group is set to 20mm, thickness of 3 g/Ah and a separator is set [the internal resistance of a cell / a heat sinking plane product] to 0.2mm for 2 and the amount of electrolytic solutions 100cm, and the measurement result of the temperature rise of the cell at the time of charge and discharge when changing the ionic conductivity of the electrolytic solution with 370 - 650 mS/cm and a cycle life is shown in the related following (table 8) of the ionic conductivity of the electrolytic solution, and a temperature rise and a cycle life. In addition, the ionic conductivity of the electrolytic solution was adjusted to the predetermined value by changing the specific gravity of the electrolytic solution.

[0051]
[A table 8]

電池内部抵抗 [mΩ]	極群厚み [mm]	放熱面積 [cm²]	液量 [g/Ah]	セパ°厚み [mm]	イオン伝導度 [mS/cm]	利用率 [%]	温度上昇 [°C]	寿命サイクル
4	20	100	3	0.2	370	75	12	400
					400	96	7	900
					500	98	5	1000
					600	96	7	900
					650	88	13	400

[0052] As shown above (table 8), when the ionic conductivity of the electrolytic solution was 400 mS/cm, 500 mS/cm, and 600 mS/cm, 7 degrees C, 5 degrees C, 7 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 900, 1000, and 900, respectively. On the other hand, when the ionic conductivity of the electrolytic solution is 370 mS/cm, the temperature rise of the cell at the time of charge and discharge becomes high with 12 degrees C, and the cycle life of a cell is short with 400. Moreover, when the ionic conductivity of the electrolytic solution is 650 mS/cm, the temperature rise of the cell at the time of charge and discharge becomes high with 13 degrees C, and the cycle life of a cell is short with 400. case the ionic conductivity of the electrolytic solution is small -- electrolytic-solution specific gravity -- small -- volume (cc) -- since it becomes excessive and reaction resistance of an electrode becomes large, it is thought that the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become large. Moreover, when the ionic conductivity of the electrolytic solution is large, electrolytic-solution specific gravity is large, volume (cc) decreases, even if heat dissipation nature is the same, since the amount of accumulation is governed with the electrolytic solution with the largest heat capacity, the amount of accumulation also decreases, and it is thought that the temperature rise of a cell becomes large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short.

[0053] Therefore, as for the ionic conductivity of the electrolytic solution, it is desirable that it is 400 - 600 mS/cm.

(7) To the related following (table 9) of the thermal conductivity of a battery case ingredient, and a temperature rise and a cycle life Set it as the desirable value which explained the internal resistance of a cell,

the thickness of an electrode group, a heat sinking plane product, the amount of electrolytic solutions, the thickness of a separator, and the ionic conductivity of the electrolytic solution in above-mentioned (1) - (6), and the thickness of a battery case is set as 1.0mm. The measurement result of the temperature rise of the cell at the time of charge and discharge when changing the thermal conductivity of a battery case ingredient with 0.13 - 0.18 W/m-K and a cycle life is shown. The thermal conductivity of a battery case ingredient is governed by the thermal conductivity of the resin to be used, and is governed by the compounding ratio by polymer alloy resin.

[0054]

[A table 9]

電槽厚み [mm]	熱伝導度 [W/m・K]	利用率 [%]	温度上昇 [°C]	寿命サイクル
1.0	0.13	82	14	400
	0.14	88	11	500
	0.15	93	7	900
	0.18	95	5	1000

[0055] As shown above (table 9), when the thermal conductivity of a battery case ingredient was 0.15 W/m-K and 0.18 W/m-K, 7 degrees C, 5 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 900 and 1000, respectively. On the other hand, when the thermal conductivity of a battery case ingredient is 0.13 W/m-K and 0.14 W/m-K, the temperature rise of the cell at the time of charge and discharge is as high as 14 degrees C and 11 degrees C respectively, and the cycle life of a cell is short with 400,500, respectively. When the thermal conductivity of a battery case ingredient is small, the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. is promoted, and it is thought that the cycle life of a cell also becomes short.

(8) To the related following (table 10) of the thickness of a battery case, and a temperature rise and a cycle life Set it as the desirable value which explained the internal resistance of a cell, the thickness of an electrode group, a heat sinking plane product, the amount of electrolytic solutions, the thickness of a separator, and the ionic conductivity of the electrolytic solution in above-mentioned (1) - (6), and the thermal conductivity of a battery case ingredient is set as 0.2 W/m-K. The measurement result of the temperature rise of the cell at the time of charge and discharge when changing the thickness of a battery case with 0.4-1.6mm and a cycle life is shown.

[0056]

[A table 10]

電槽厚み [mm]	熱伝導度 [W/m・K]	利用率 [%]	温度上昇 [°C]	寿命サイクル
0.4		96	4	400
0.5		96	4	900
0.8		96	5	1000
1.0	0.2	96	5	1000
1.2		95	5	1000
1.5		93	7	900
1.6		86	12	500

[0057] As shown above (table 10), when the thickness of a battery case was 0.5mm, 0.8mm, 1.0mm, 1.2mm, and 1.5mm, 4 degrees C, 5 degrees C, 5 degrees C, 5 degrees C, 7 degrees C, and the cycle lives of the temperature rise of the cell at the time of charge and discharge were 900, 1000, 1000, 1000, and 900, respectively. On the other hand, when the thickness of a battery case is 0.4mm, although the temperature rise of the cell at the time of charge and discharge is 4 degrees C, the cycle life of a cell is short with 400. Moreover, when the thickness of a battery case is 1.6mm, the temperature rise of the cell at the time of charge and discharge becomes high with 12 degrees C, and the cycle life of a cell is short with 500. Since heat dissipation nature becomes good when the thickness of a battery case is small, the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become small, but since the

thickness of a battery case runs short to cell internal pressure, a battery case deforms and it is thought that the cycle life of a cell becomes short. Moreover, since heat dissipation nature worsens when the thickness of a battery case is large, it is thought that the calorific value of the cell at the time of charge and discharge, as a result the temperature rise of a cell become large. And if the temperature rise of a cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a cell becomes short.

[0058] Therefore, it is desirable for the thermal conductivity of a battery case ingredient to be 0.15 or more W/m-K, and for the thickness of a battery case to be 0.5-1.5mm from the result of (7) and (8).

[0059] As a battery case ingredient which fulfills this condition, resin ingredients, such as a polymer alloy which makes polyphenylene ether resin and polyolefin resin a subject, can be mentioned, for example.

[0060] Next, 3-40 square shape nickel and hydrogen batteries equipped with the above configurations (cell) were electrically connected to the serial, and the unit cell was produced.

[0061] The perspective view of the one battery case when connecting electrically six square shape nickel and hydrogen batteries (cell) to a serial, and constituting a unit cell in drawing 2 , is shown. As shown in drawing 2 , the electrode group (not shown) is really which shared the short side face as a septum 7, and fabricated in one the six rectangular parallelepiped-like battery case 6 which has the short side face where width of face is narrow, and the long side face where width of face is wide contained in each battery case 6 of a battery case 8. That is, adjoining cells are electrically connected to the serial in the upper part of a septum 7. The pole terminal (not shown) of the above-mentioned unit cell is prepared in the upper part of the end wall 9 of ends, respectively. The up release side of a battery case 8 is really blockaded in one with up covering (not shown). Moreover, in the long side face of a battery case 8, the rib-like projection 10 for forming the path which can pass a cooling medium is really formed between adjoining unit cells.

(9) In the unit cell which connected and constituted electrically six square shape nickel and hydrogen batteries (cell) in the serial at the related following (table 11) of the thermal conductivity per unit cell, and a temperature rise and a cycle life The internal resistance of each cell, the thickness of an electrode group, a heat sinking plane product, the amount of electrolytic solutions, the thickness of a separator, It is set as the desirable value which explained the ionic conductivity of the electrolytic solution in above-mentioned (1) - (6), and the measurement result of the temperature rise of the unit cell at the time of charge and discharge when changing the thermal conductivity per unit cell with 0.2 - 0.4 W/m-K and a cycle life is shown. In addition, the thermal conductivity per unit cell was adjusted to the predetermined value by changing the compounding ratio of a battery case resin ingredient, and the thickness of a battery case.

[0062]
[A table 11]

熱伝導度 [W/m・K]	利用率 [%]	温度上昇 [℃]	寿命サイクル
0.2	82	13	400
0.3	95	6	900
0.4	96	5	1000

[0063] As shown above (table 11), when the thermal conductivity per unit cell was 0.3 W/m-K and 0.4 W/m-K, 6 degrees C, 5 degrees C, and the cycle lives of the temperature rise of the unit cell at the time of charge and discharge were 900 and 1000, respectively. On the other hand, when the thermal conductivity per unit cell is 0.2 W/m-K, the temperature rise of the unit cell at the time of charge and discharge is as high as 13 degrees C, and the cycle life of a unit cell is short with 400. Since heat dissipation nature worsens when the thermal conductivity per unit cell is small, it is thought that the calorific value of the unit cell at the time of charge and discharge, as a result the temperature rise of a unit cell become large. And if the temperature rise of a unit cell becomes large, disassembly of the decline in charging efficiency, the separator arranged in a cell, the binder in an electrode, etc., etc. will be promoted, and it will be thought that the cycle life of a unit cell becomes short.

[0064] Therefore, as for the thermal conductivity per unit cell, it is desirable that they are 0.3 or more W/m-K.

[0065] Thus, by constituting a unit cell using the square shape nickel and the hydrogen battery (cell) set as the desirable value explained in above-mentioned (1) - (9), and setting the thermal conductivity per unit cell as 0.3 or more W/m-K, a temperature rise can be controlled and the unit cell which has the cell property which was excellent in high power also in the repeat of charge and discharge or the prolonged activity can

be realized.

[0066] Next, two or more unit cells equipped with the above configurations were electrically connected to a serial and/or juxtaposition, and the group cell was produced. The path which can pass a cooling medium is prepared between adjoining unit cells. Also in this case, by constituting a group cell using the unit cell set as the desirable value explained in (9), the temperature rise was able to be controlled and the group cell which has the cell property which was excellent in high power also in the repeat of charge and discharge or the prolonged activity was able to be realized.

[0067]

[Effect of the Invention] As explained above, according to this invention, the balance of calorific value, heat release, and the amount of accumulation can be optimized, and the square shape alkaline battery which has the cell property which was excellent in high power also in the repeat of cha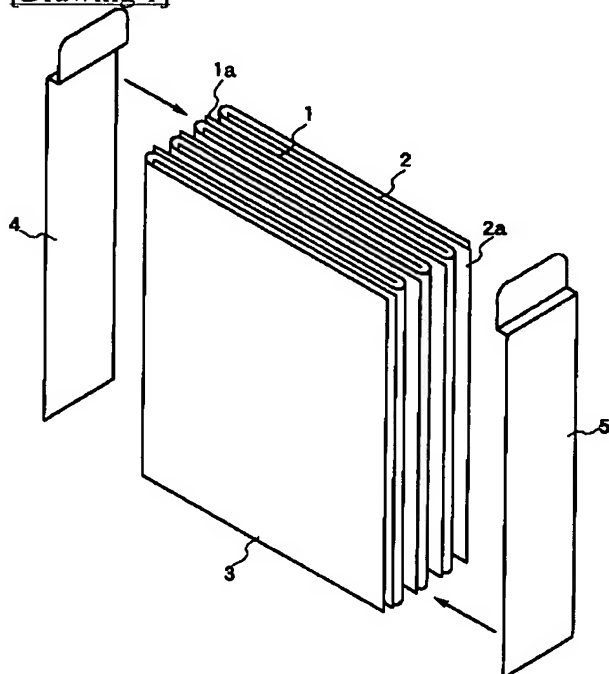rge and discharge or the prolonged activity can be realized. Moreover, by using the square shape alkaline battery of this invention, a temperature rise can be controlled and the unit cell and group cell which have the cell property which was · excellent in high power also in the repeat of charge and discharge or the prolonged activity can also be realized.
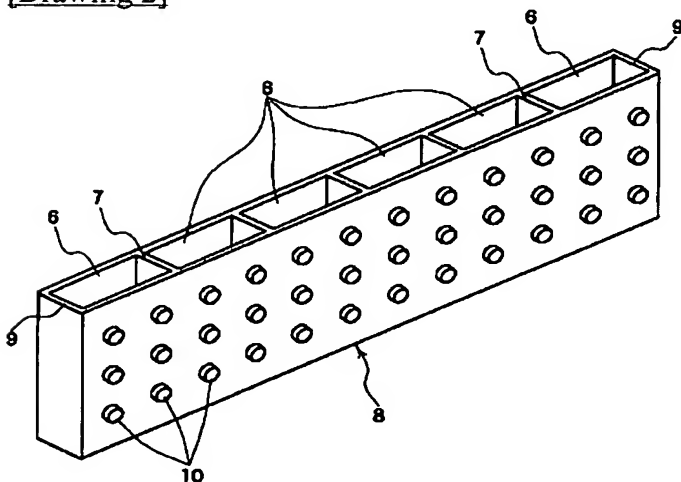

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]

[Drawing 2]

[Translation done.]